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S. No. of Question Paper 2909

Unique Paper Code **2222514802 /2512514801**

Name of the Paper **Digital and Optical Communication**

Name of the Course **B.Sc. (Prog.) - Physics_NEP: UGCF-2022**

Semester **VIII (DSC)**

Duration: **3 Hours** Maximum Marks: **90**

(Write your Roll No on the top immediately on receipt of this paper.)

Attempt **five** questions in all, including Question No. 1 which is **compulsory**.

All questions carry equal marks.

1. Answer the following questions: (6×3=18)
   (a) Define multiplexing in digital communication system. What is the advantage of multiplexing?
   (b) The refractive indices of core and cladding are 1.50 and 1.48 respectively. Calculate the numerical aperture (NA).
   (c) What are the basic characteristics of a laser diode?
   (d) What are shot noise and thermal noise in optical detection?
   (e) Define Quadrature Phase Shift Keying (QPSK).
   (f) State the condition for amplification of radiation in lasers.

2. (a) State sampling theorem. Explain under-sampling and over-sampling for a band pass limited signal using an appropriate example.
   (b) Define a random process and a stationary process. Explain the concepts of autocorrelation function and its relation to power spectral density (PSD)
   (c) Explain the concept of cross-correlation of signals and its significance.

(6, 6, 6)

3. (a) Describe Frequency Shift Keying (FSK) modulation technique. How does it differ from ASK in terms of noise immunity and bandwidth requirements?

   (b) Discuss the principle of Quadrature Phase Shift Keying (QPSK) with diagram. Explain how it improves bandwidth efficiency compared to binary PSK.

   (c) What is M-ary coding? Explain its basic concept with a simple example.

(6, 6, 6)

3. (a) Differentiate between analog and digital modulation (direct modulation) in optical communication systems. Discuss their advantages and limitations.

   (b) Explain the characteristics of a fiber optic communication system. Discuss in detail the methods used for characterization of an optical fiber, including measurement of core radius and numerical aperture. (6, 12)

4. (a) Explain the V–I characteristics of an LED and LASER Diode using a labelled diagram. Discuss how forward bias affects light emission and efficiency.

   (b) Explain the fundamental processes of absorption, spontaneous emission, and stimulated emission of radiation. Derive the condition for amplification of radiation using Einstein coefficients, and discuss the concept of population inversion in detail.

(6, 12)

5. (a) Explain the construction and working of a PIN photodetector. Why is the intrinsic (i) region important?

   (b) What is cut-off wavelength in optical fibers? Using Marcuse's formula, explain how it depends on fiber parameters.

   (c) A signal has a maximum frequency of 10 kHz and is sampled at the Nyquist rate. Each sample is encoded using an 8-level (M = 8) M-ary system. Find:

   (i) Sampling frequency

   (ii) Bits per symbol

   (iii) Bit rate

(6, 6, 6)

6. (a) Define Signal to Noise (SNR) ratio and its effects on the performance of communication signal.

   (b) How SNR can be improved for a communication channel?

   (c) A communication channel has a bandwidth of 1 MHz and signal to noise ratio SNR of 20 dB.

      (i) Convert this SNR from dB to linear scale.

      (ii) Using Shannon capacity formula, estimate the maximum data rate of the channel.

(7, 7, 4)